

LAND DEGRADATION AND CLIMATE CHANGE

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Abstract

Land degradation is a worrisome phenomenon that is closely related to climate change, contributing to the accentuation of climate change and at the same time being caused by it. Land degradation is mainly caused by human activities that lead to soil pollution or degradation, by agricultural practices, by forestry management, urbanization but also by extreme weather phenomena such as floods and droughts. Desertification is also a land degradation phenomenon that is caused by climate change and that contributes to intensifying climate change. This study aims to summarize the main causes leading to land degradation and which have a major contribution to the exacerbation of climate change, but also to identify the appropriate measures to avoid, reduce and reverse land degradation. At the same time, this study identifies the main direct and indirect impacts of land degradation on people's way of life. Regarding the impact of climate change on land degradation, the study identifies ways in which climate change accentuates land degradation processes.

Key words: *climate change, land degradation, impact.*

INTRODUCTION

Land degradation is a global problem that threatens economic and social development all over the world. Land degradation is a rather complex process, caused by various anthropogenic activities but also by climatic conditions that reduce the productive potential of the land, at the same time reducing much-needed agricultural production in the context of the continuous increase in the global population. At the same time, in certain areas where agriculture is the main occupation of the people, land degradation increases the vulnerability of farmers to food shortages, possibly jeopardizing even the possibility of people's survival. Land degradation is a complex process to define, with results that are difficult to quantify, but which represents in general terms a permanent or temporary loss or reduction of the productivity of natural capital in various forms, followed by a loss or reduction of the economic value of the land. According to the study carried out by UN Environment, in partnership with the Global Environment Facility (GEF), one-third of the Earth's land surface is degraded, affecting more than 2.6 billion people and costing us as much as \$10.6 trillion every year in lost ecosystem services. The pressure on agricultural land will

increase significantly in the next period, until the year 2050 an increase in the need for food is presumed to increase by approximately 50 percent, and ensuring this need will represent a major challenge. (United Nations et al., 2017). During the Conference of the Parties to the United Nations Convention to Combat Desertification (UNCCD), held on 9-10 September 2019 in New Delhi, it was emphasized that desertification/land degradation and drought undermine health, development and prosperity in all regions and the effects of degradation of land and drought are felt most by vulnerable people. Also, within this conference organized under the United Nations Decade on Ecosystem Restoration (2021-2030), it was proposed as a Sustainable Development Goal to achieve the neutrality of land degradation by promoting practices that conserve and restore land and soil affected by desertification/land degradation, drought and floods. (United Nations et al., 2017).

MATERIALS AND METHODS

The purpose of this study was to summarize the main causes of land degradation and how climate change contributes to land degradation, but also how degraded land exacerbates climate change. In order to carry out this study, a

literature review was carried out to provide a better understanding of these phenomena and the intensity of them at a global level. At the same time, the research also focused on how land degradation affects people's livelihoods, but also on an identification of the main measures that could be taken to prevent land degradation and to restore degraded land.

RESULTS AND DISCUSSIONS

Land degradation leads to a temporary or permanent loss of the productive capacity of the land, manifested by a reduction in biomass, a loss of current or potential productivity of the land, a loss of biodiversity and even a loss of organic soil content (Kemalo et al., 2021) Anthropogenic activities that cause land degradation are the following:

- **Deforestation** leads to the degradation of forest land and is considered the main cause leading to the loss of biodiversity (loss of habitats and species).

According to the data presented by FAO, forests have an uneven global distribution and occupy over 31 percent of the global land surface, and represent 4.06 billion hectares, or approximately 5000 square meters per person. Forests are not equally distributed around the globe, the first 10 countries with the largest areas covered by forests at the global level owning two-thirds (66 percent) of global forests (Table 1) (FAO and UNEP, 2020).

Table 1. Global distribution of forests showing the ten countries with the largest forest area, 2020 (FAO and UNEP, 2020)

Country	Forest area (million hectares)	% of world forest
Russian Federation	815	20.1
Brazil	497	12.2
Canada	347	8.5
United States of America	310	7.6
China	220	5.4
Australia	134	3.3
Democratic Republic of Congo	126	3.1
Indonesia	92	2.3
Peru	72	1.8
India	72	1.8

Deforestation to convert land to agricultural land or other uses can lead to land degradation. Since 1990, it is estimated that approximately 420 million hectares of forest have been lost through conversion to other land uses, with the expansion of agriculture continuing to be the

main cause of deforestation and forest degradation, being large-scale agriculture. (FAO and UNEP, 2020)

The average annual rate of forest area change, which considers forest expansion and deforestation (Figure 1), decreased from -7.84 million ha/year in the period 1990-2000 to -4.74 million ha/year in the period 2010-2020 (FAO and UNEP, 2020).

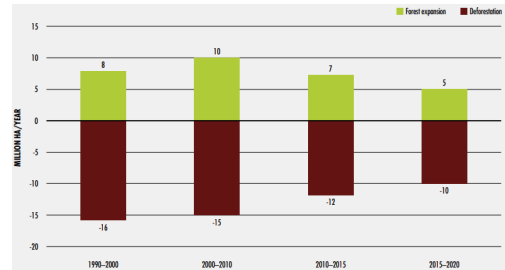


Figure 1. Global forest expansion and deforestation, 1990-2020 (FAO and UNEP, 2020)

- **Land use changes** - are accelerated by economic development and population growth in certain areas, especially in developing countries. Thus, a permanent pressure is exerted on agricultural lands in the vicinity of human agglomerations, by converting them into buildable land for residential areas, industrial areas or for the development of infrastructure. As a result of these pressures, arable land is decreasing dramatically, representing a major threat to food security. (Yuzhe et al., 2011).

Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. In 2020, globally, agricultural land occupied an area of approximately 47,388,929 sq. kilometres according to the World Bank collection of development indicators. This area represents around 36.5 percent of the world's land area. (The World Bank Group, 2023)

- **Unsustainable land management**, includes agricultural over-exploitation that reduces the supply of soil organic matter as well as its resistance to erosion.

- **Soil erosion** - is a major problem faced by the land under the action of various environmental factors. Erosion and transport of soil material is mainly caused by water through precipitation or erosion due to runoff or seawater erosion.

Along with the eroded soil, the water also picks up various residues of pesticides and organic or inorganic fertilizers applied to the soil. Other causes are wind erosion and various human activities. Erosion reduces soil fertility and implicitly its economic value, and the intensity of the phenomenon is proportional to the degree of vegetation coverage of the soil. Soil erosion is also accentuated on recently deforested sloping land where the vegetal carpet is not sufficiently developed (Figure 2). Wind erosion is a phenomenon that cannot be neglected. According to some studies, during a storm, up to 15 tons of soil can be lost from one hectare, which represents a decrease in the thickness of the soil layer by up to 1 mm (Alam, 2014).



Figure 2. Soil erosion after deforestation
(Poiana Horea, Cluj County, Romania, 2021)

Land degradation through erosion also has an impact on other long-distance environmental factors, such as the aquatic and marine environment, and on human health (through wind erosion). Eroded soil is not only a loss of resources but can also be a source of pollution, especially of air and water (Alam, 2014).

- **Desertification** - is a phenomenon of extreme long-term land degradation in arid, semi-arid, and dry sub-humid areas, known as drylands, produced by human activities and climatic conditions, which leads to the loss of at least one of the characteristics of the land: biological productivity, ecological integrity, or economic value. Invasive plants also contribute to the phenomenon of deforestation (Assennato, 2020; Mirzabaev, 2019).

- **Land salinization** - occurs naturally in drylands regions of the world, as a result of

hydrological changes in the soil, by increasing the mineralized groundwater level, which leads to an increase in the salt content of the soil. This phenomenon also occurs due to anthropogenic causes because of improper irrigation of the land (Mirzabaev, 2019).

- **Land compaction** - occurs because of agricultural works carried out with heavy equipment that change the structure of the soil leading to its compaction, the reduction of soil porosity and its hydraulic properties resulting in the reduction of plant root growth followed by the reduction of soil productivity by up to 50 percent (Shaheb, 2021).

- **Urbanization** - is an important trend especially in developing countries. The expansion of residential areas around cities reduces the areas occupied by agricultural land, produces changes in the vegetation that naturally occupies the soil, changes the degree of soil compaction and aero-hydric properties of the soil. The topsoil is mixed with the lower organic matter-poor layers and is often mixed with various building material scraps and waste. Microclimatic conditions in urbanized areas often change and the level of pollutants in the soil increases.

- **Grazing** is also associated with soil compaction depending on its intensity (heavy, moderate, or light) and overgrazing. A study published in 2020 showed that compared to ungrazing, the heavy and moderate grazing significantly increased soil bulk density and penetration resistance and reduced soil organic carbon and total nitrogen. Heavy grazing significantly decreased nitrate (NO_3^-), water content, and microbial biomass carbon. All this study concluded that light grazing significantly increased soil organic content and NH_4^+ (Lai et al., 2020).

- **Agricultural practices** have an impact on soil degradation. Inadequate agricultural practices can lead to the reduction or elimination of the vegetal cover, reducing the ability of the soil to store water, which thus becomes vulnerable to erosion if measures are not taken to reduce the rate of water runoff on these lands (Alam, 2014).

- **Industrial land use** can lead to an impact on environmental factors, especially by increasing the areas occupied by various types of waste, but also by increasing the level of air pollution,

which is a vector for the transfer of pollutants into the soil.

- **Natural disasters** such as earthquakes, volcanic eruptions, landslides, floods, avalanches and tsunamis are direct causes of land degradation, leading to land deformation and topsoil degradation (Sharma, 2019).

Climate change exacerbates land degradation in the following ways:

- **Increasing global temperature** intensifies land degradation processes. As global temperatures increase, the hydrological cycle also intensifies, thus producing more intense precipitation, which is an important factor in the intensification of erosion phenomena (Olson et al., 2019; Sandu et al., 2014). The increase in global temperature increases the risk of wildfires, which are also responsible for intensifying the phenomena of desertification.

- **Thermal stress** is accentuated because of climate change that produces more intense and more frequent heat waves, which lately most often coincide with periods of soil drought, increasing the temperature and decreasing the air humidity. The decrease in air humidity can modify human heat stress which sometimes produces serious effects on human health (Wouters et al., 2022).

- **Sea level rise** because of climate change affects coastal areas by intensifying erosion, but also by intensifying the salinization of groundwater through seawater intrusion. (Mirzabaev et al, 2019). Sea level rise can lead to the permanent loss of large areas of land.

- **Changing precipitation patterns** caused by climate change play an important role in a multitude of processes occurring at ground level. Agricultural and ecosystem productivity is closely related to soil moisture levels, soil biogeochemical processes are influenced by temperature and soil moisture (Roque-Malo et al., 2017). Changing the precipitation regime can distort the distribution of precipitation globally, intensifying erosion phenomena in some areas, substantially changing the water supply of the soil in other areas, all these effects leading to land degradation. Changing rainfall patterns may lead to more frequent and more intense flooding. At the same time, the change in the rainfall regime can have an impact on agriculture, which will be affected by the lack of water in the soil in some areas of

the world and which will develop in other areas where the rainfall regime will be higher. The intensification of drought phenomena in some areas diminishes the vegetation of the land, intensifying the phenomena of erosion and leading to the depletion of nutrients in the soil.

The impact of climate change on agriculture can manifest itself differently globally by decreasing agricultural productivity in some areas and intensifying agriculture in other areas, which can cause soil degradation in areas not affected by such phenomena in the past (Olson et al., 2019).

- **Intensification of cyclones** is a likely cause of climate change, leading to intensification of rainfall and wind intensity along coastal regions associated with increased relative air humidity in these areas, as well as intensification of flooding and land erosion phenomena in coastal areas (Sarkar, 2022).

- **Permafrost thawing** is also considered a threat to the integrity of polar and subpolar infrastructure. This impact is often linked to anthropogenic global warming. Infrastructure damage was observed in up to 80 percent of buildings in some cities in Russia and about 30 percent of some road surfaces in the Qinghai-Tibet Plateau. It is estimated that these damages will continue in the next period, until 2050, 30-50 percent of critical circumpolar infrastructure thought to be at high risk (Hjort et al., 2022).

How land degradation affects people's livelihoods:

- **Affect the standard of living**

The number of people whose livelihood depends directly on natural resources for subsistence, food security and income, and who depend on degraded land is estimated at 1.5 billion worldwide. Land degradation reduces the productivity of the land and increases the workload of managing the land, leaving people vulnerable to extreme climatic events, with consequences such as poverty and food insecurity, and in some cases to migration, conflicts and the loss of cultural heritage (Olson et al., 2019).

- **Problems at the political level**

Public decision-making authorities in areas affected by land degradation are often held responsible for making wrong decisions or not making certain decisions in time. All of them

are subject to pressure from the public who are increasingly aware and concerned about the causes and effects of climate change and are also responsible for integrating climate change adaptation and mitigation measures into national, regional and local level plans and programs. As the effects of climate change become more evident and natural disasters become more intense and frequent, causing major effects especially on agriculture, people will suffer, especially in poor countries, all of which may cause riots and political instability.

- **Social and economic**

The social and economic consequences of land degradation are associated with the low economic development of the areas occupied by such lands but also with the high environmental costs for adaptation to present and future conditions. Economic instability and the reduction of the means of subsistence of the local community can lead to the migration of the population from the traditional lands from which they will no longer be able to secure their daily livelihood.

To reduce the areas affected by land degradation, the following measures can be taken:

- **Land restoration** has the main purpose of accelerating the natural recovery rate of degraded lands. Reforestation of deforested areas can reverse the trend of biodiversity loss, but it is also an effective method of capturing carbon from the atmosphere, but it can also bring economic advantages. Some researchers have shown that investments in environmental protection can lead to an increase in Gross Domestic Product per capita over time (Todea, 2018).

- **Land revegetation** prevents erosion and desertification, also leading to the improvement of soil quality over time. Agricultural management measures based on agroforestry can also be promoted because it is well known that agroforestry improves soil conditions.

- **Conservation tillage** and replenishment of soil organic matter can restore poor soils.

- **Restoring the natural hydrology of rivers** can increase the frequency of floods in river floodplains, the deposited silt increasing soil fertility.

- **Public involvement in decision-making.** In large brownfield restoration projects, it is

absolutely necessary to involve the local community from the early stages of planning, to identify and resolve potential conflicts, to take into account possible conflicting points of view and to present to them the main objectives of the restoration project. The local community, which has a key role in the sustainable and long-term restoration of degraded land, can often be composed of the local population, public government authorities, NGOs, the academic community, and may have different interests, goals and knowledge about local ecosystems, which must be taken into account (Santini, 2022).

CONCLUSIONS

Land degradation is a worrying phenomenon, closely related to climate change, which manifests itself over large areas worldwide, the effects of which are not fully quantified economically in terms of lost productivity. Land degradation is mainly caused by anthropogenic activities, but also by natural causes, the phenomenon of degradation being accentuated by climate change, but in turn, degraded land contributes to intensifying the intensity of climate change. Land degradation affects people's well-being but can also cause political, economic and social disturbances in areas strongly affected by these phenomena.

In the context of the intensification of climate change, for the well-being of future generations, it is necessary to identify and preserve lands unaffected by degradation phenomena, and to apply management measures in order to preserve their productivity. At the same time it is vital that we restore our degraded land, and prevent further damage, by adopting sustainable management practices now.

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